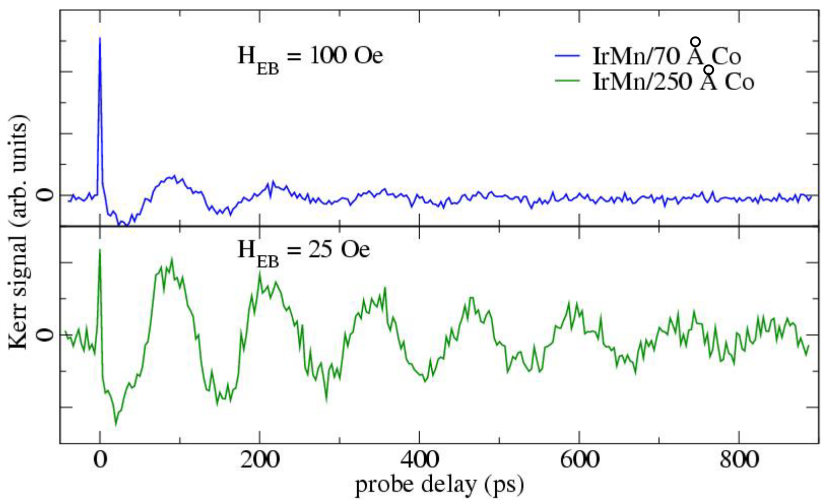
# Ultrafast Laser Studies of Magnetization Dynamics in Ferromagnetic Thin Films

**Anne Reilly, College of William and Mary** **DMR-0094225**

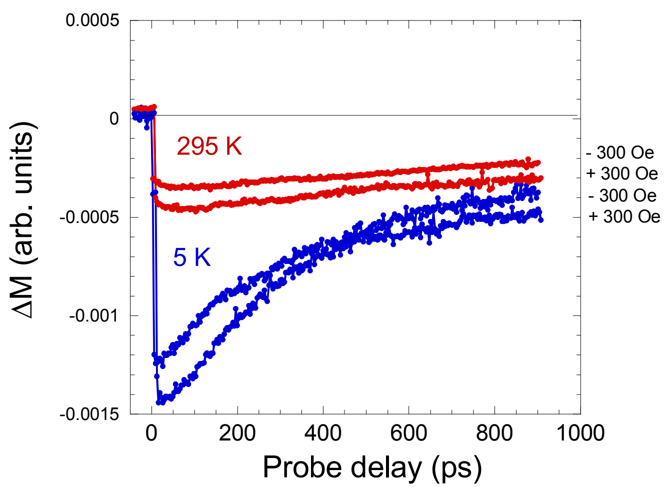
*How fast can we manipulate magnetic properties?*

*Can we develop new probes of magnetic behavior?*




We have excited coherent spin waves using ultrashort laser pulses in several types of magnetic systems, including magnetic multilayers used as sensors in computer hard drives. Studying these spin waves will allow us to determine how fast magnetism can be manipulated

We are studying ultrafast changes in optical absorption and Kerr effect which are related to the magnetic response in half-metallic $CrO_2$. These probes may be used in-situ during growth to optimize the material.



Dr. Reilly's group is using the latest ultrafast laser technology to explore magnetism in thin films. They are hoping to provide some answers to these questions: "How fast can we manipulate magnetic properties?" and "Can we develop new probes of magnetic behavior?" They are using a technique called "pump and probe". A laser pulse, less than one-one-trillionth seconds in duration, changes the magnetism of a thin film. A second "probe" laser pulse senses how the magnetism is changing in time by taking "snapshots" at specific times. The first figure shows direct detection of the oscillating magnetization in a thin film after pumping (the electronic spins are oscillating like small tops) on a picosecond timescale. Dr. Reilly's group is also looking for ways to optically detect magnetic processes, particularly in the important class of materials known as half-metals. If optical studies succeed, then the materials can be grown while their desired properties are monitored by shining a laser beam on them. This is relatively easy to do, and gives powerful information which will aid in the growth of these materials.

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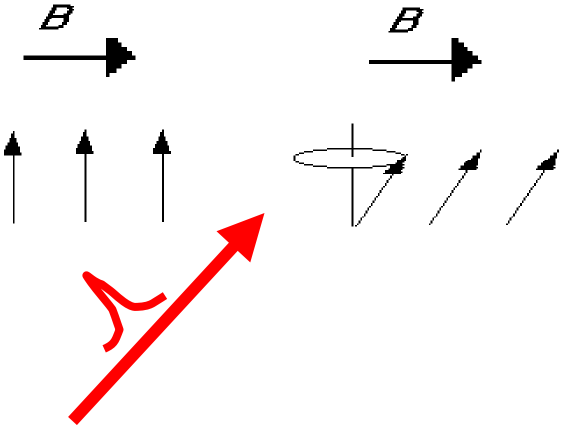
**Education:**

Two graduate students (Keoki Seu and Hailong Huang) are receiving training in magnetic materials and ultrafast laser techniques. Five undergraduates (Haley Showman, John Lesoine, Matthew Schu, Dimitar Vlasserev, Andrew Busch) and one high school student have also taken part in this research. This grant has also supported incorporation of experiments in modern optics and magnetic materials into undergraduate laboratory classes.

**Societal Impact:**

Answering questions on how fast magnetism can be manipulated and how to produce better magnetic materials will have great impact on sensor design and computer technology.



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Answering questions on how fast magnetism can be manipulated and how to produce better magnetic materials will advance sensor design and computer technology which relies on magnetic materials.